

Mathematics Depth of Knowledge Levels – ANSWER KEY

Grade 4 Items:

- 1) Level 2. The choices offered indicate that this item is intended to identify students who would simply subtract 9 minus 1 to get an 8. More than one step is required here. The students must first recognize the difference between a.m. and p.m. and make some decisions about how to make this into a subtraction problem, then do the subtraction.
- 2) Level 4. This is a complex open-ended problem requiring students “to make several connections and apply one approach among many.” It requires the students to plan and organize, and to weigh solutions based on different kinds of criteria. Students should be allowed at least 20 minutes for this problem, which is an extended period of time for a test item.
- 3) Level 1. Students only need to be able to recognize even numbers.
- 4) Level 3. “An activity that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3.” Since there are multiple possible approaches to this problem, the student must make strategic decisions about how to proceed, which is more cognitively complex than simply applying a set procedure or skill.
- 5) Level 1. This measurement item requires no analysis of the map itself, since the route in question is a straight line. If the line were not straight, this item would require estimation and perhaps even calculation, making it Level 2 or 3.

Grade 8 Items:

- 6) Level 1. The first thing to note is that this is not really a geometry item. Rather, it simply requires students to notice an easy, routine pattern. DOK levels are difficult to assign for many pattern-recognition problems, because they depend on how routine the pattern is. This particular pattern is immediately recognizable and requires no processing, but a more complex pattern could make this a Level 2 or even Level 3 item.
- 7) Level 2. This item is included in order to contrast it with the previous item. Pattern recognition is required, but the non-routine nature of this pattern brings the item up to a higher DOK level. Some analysis and generalization is required in order to understand and extend this pattern.
- 8) Level 2. There are a number of different concepts and procedures that can be used for this problem, rather than an obvious, simple one. Students must not only be able to *identify* different representations of rational numbers (Level 1), but also to *manipulate* and *compare* these representations (Level 2). This means that numerous interdependent and non-trivial steps are involved here. However, this does not require any conjecturing, planning, abstracting, or explaining, so it is not Level 3.

This item demonstrates the importance of knowing whether calculators are allowed on the examinations or not. If a calculator were allowed on this examination, this would clearly be Level 1, instead of Level 2.

9) Level 2. This is an example of how a problem that is multiple choice can reduce its DOK level. If the multiple choices were removed here and the problem were left open-ended, it would be Level 3. But here the student need only weigh the options against one another, easily discarding “type of survey used” and “ages of people surveyed” as bogeys. So they can easily determine that C is immediately better than A or D, without even having to think analytically or creatively about why percent values shown or number of people surveyed would be important information to know.

10) Level 3. This item can be approached through a number of viable strategies: pattern recognition, guess-and-check, algebra, etc. This freedom means that the student must make choices and assumptions. Furthermore, no matter what strategy she employs, she must keep track of a complex logical chain. The multiple choices provided do not make this task any less complex.

Grade 11 Items:

11) Level 3. This is another example of an item that is at Level 3 without being open-ended. This item requires generalization, reasoning, and hypothesis testing, involving some creativity in choosing examples that test the hypotheses.

12) Level 4. This problem requires students to form game strategies, create data, notice number patterns, and justify how and why those patterns arise. It involves inductive, deductive, and strategic reasoning over an extended period of time, perhaps 30 minutes. This may even be a problem best done in pairs or groups within a testing environment.

13) Level 2. This item is not Level 1 because it is not routine, nor does it focus on a memorized definition or procedure. In fact, it involves numerous steps, because it requires students to compare several different pairs of shapes before arriving at the correct answer. For these reasons, many spatial reasoning items are Level 2.

Note that this may be coded as a source-of-challenge item, because choice C seems to be drawn in a misleading way.

14) Level 3. This item gives the student a new definition and asks her to use it as a basis for reasoning. In order to ascertain whether the student really understands the asymptotic behavior that makes a 6% effective rate impossible, this item *must* be open-ended. This is why most Level 3 items are open-response items, because the complexity of thinking they require the students to display could not be displayed using the multiple choice option.

15) Level 3. If a multiple-choice item is Level 3, often it is because the multiple choices do not constrain or guide the possible solutions. The choices here allow for *all* possible responses to this item, including the response that the problem cannot be solved. This gives such an item the character of an open-ended item, even though it is not one